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SUBJECT: DRAFT UPDATE TO THE PESTICIDE VOC INVENTORY: ESTIMATED EMISSIONS 1990–2006

I. OVERVIEW

This memorandum summarizes the Department of Pesticide Regulation's (DPR's) update of estimated pesticide volatile organic compound (VOC) emission data, with particular attention to May–October "ozone season" emissions in California's five nonattainment areas (NAAs): Sacramento Metropolitan (1), Metro San Joaquin Valley (2), Southeast Desert (3), Ventura (4), and South Coast (5). An electronic file containing detailed statewide 1990–2006 data is available by download from DPR's Web site at <http://www.cdpr.ca.gov/docs/pur/vocproj/vocmenu.htm> along with a variety of VOC documentation.

The 1990–2006 VOC inventories incorporate new emission potential (EP) data for several hundred products. These data reflect new thermogravimetric analyses requested by DPR in 2005. Thermogravimetric analysis is currently the most accurate method for estimating VOC content of pesticide products. DPR requested the data for most liquid products included in the inventory that had not been tested previously. VOC emissions described here incorporate the thermogravimetric analysis data submitted, reviewed, and approved as of August 2007.

The 1990–2006 VOC emissions reported are based on DPR's 2006 pesticide use data. NAA goals discussed are those originally described in the January 8, 1997, Federal Register, page 1170, Emission Reductions (Federal Register, 1997), as well as those described in the relief order issued April, 26, 2006, following the decision in *El Comité Para Bienstar de Earlimart v. Helliker,* 416 F. Supp. 2d 912, (E.D. Cal. 2006). Under the court order a 20 percent reduction in pesticide VOC emissions relative to 1991 as the base year is required.

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To date, DPR has reported an unadjusted emission inventory that assumes the entire volatile portion of a fumigant product eventually volatilizes, contributing to atmospheric VOC loadings. However, field studies have shown that actual emissions from soil-applied fumigants such as methyl bromide vary by application method and are generally less than 100 percent. DPR has developed an adjustment procedure to account for the effect of application method on reducing fumigant VOC emissions.

Procedure for Calculating Unadjusted and Adjusted Volatile Organic Compound Emissions

The unadjusted inventory is based on the premise that VOC emission from a single application of fumigant or nonfumigant product is equal to the amount used times the EP (Spurlock, 2002; 2006).

$$emission = lbs\_use \times EP$$

In the adjusted inventory the emission from a single application of a **fumigant** active ingredient (AI) is equal to the amount of AI used times the EP times the Application Method Adjustment Factor (AMAF), also referred to as the emission rating. AMAFs have been determined from field study data and are AI and application method specific (Barry et al., 2007). Since AMAFs are application method- and fumigant-specific they yield more refined estimates of fumigant VOC emissions than previous (unadjusted) assumptions.

$$emission = lbs\_use \times EP \times AMAF$$

At this time **nonfumigant** product emissions calculations use the same procedure as in the unadjusted inventory.

Usually there are several different types of application methods used for a particular fumigant in any particular NAA. Each method of use (e.g. drip, sprinkler, shank, tarp, etc.) represents a fraction of the total number of methods used and is referred to as the Method Use Fraction (MUF). The sum of all MUFs for any particular (NAA/fumigant AI) combination is one. Use practices change over time so that different MUFs are used for the baseline year (1991) as opposed to more recent inventory years. MUFs are determined in a number of different ways. For 1,3-dichloropropene the MUFs are determined from use data collected by the registrant in support of DPR's township application caps; for metam sodium and metam potassium grower/applicator surveys were conducted to determine types of applications for different crops and areas. Methyl bromide and chloropicrin MUFs are based on expert opinion and regulatory history. Finally, MUFs for dazomet and sodium tetrathiocarbonate equal one because the AMAFs for each of these two fumigants are constant, independent of application method.

VOC emissions were calculated for each nonattainment area and summed according to primary AI, application site, and emission category as defined by the Air Resources Board (ARB). The primary AI is defined as the pesticide AI present at the highest percentage in a product. If a pesticide product contains 20 percent of AI "A" and 10 percent of AI "B", all estimated emissions from that product are assigned to the primary AI "A." This approach prevents "double-counting" of emissions from products containing two AIs. Both unadjusted and adjusted emission inventory data for the top ten primary AIs contributing to May–October ozone in 2005 and 2006 are included in this memorandum. Emissions attributed to application sites (or commodities), however, are *unadjusted* because it is not possible to determine the adjusted emissions with the currently available data. ARB defines four VOC emission categories: methyl bromide emissions from agricultural applications, nonmethyl bromide emissions from agricultural applications, methyl bromide emissions from structural applications, and nonmethyl bromide emissions from structural applications. Emissions were calculated for May–October, the ozone season, and are reported as U.S. tons per day (tpd).

II. VOLATILE ORGANIC COMPOUND INVENTORY RESULTS

The main text of this document summarizes the *adjusted* pesticide VOC emission inventory data for 2005 and 2006. Data for the *unadjusted* emission inventory are given in Appendix 1. Previous reports included a summary of pesticide VOC emissions by commodity/site. At this time it is not possible to determine the breakdown of adjusted emissions by commodity, so only the unadjusted emissions are shown by commodity in Appendix 1. Table 1 and Figure 1 summarize the adjusted pesticide VOC emissions for 2005 and 2006, and compare them to the 1991 base year and goals.

TABLE 1. May–October (ozone season) *adjusted* pesticide VOC emissions and goals

NAA	1991 Emissions (tons/day)	Goal Emissions (tons/day)	2005 Emissions (tons/day)	2006 Emissions (tons/day)
1–Sacramento Metropolitan	3.072	2.457	1.375	1.502
2–San Joaquin Valley	20.088	16.070	22.895	24.159
3–Southeast Desert	0.784	0.627	0.742	0.635
4–Ventura	3.308	2.647	3.639	3.738
5–South Coast	5.089	4.071	1.983	1.501

As in previous years, even after adjusting for field conditions (AMAFs), fumigants continue contribute the most pesticide VOC emissions in most NAAs. Also consistent with previous years, pesticides formulated as emulsifiable concentrates are the other major pesticide VOC contributors, particularly in the San Joaquin Valley NAA. In almost all cases, it is the solvents included as inert ingredients of emulsifiable concentrates that contribute most of VOCs, not AIs.

In comparison to 2004:

- Sacramento Metropolitan NAA: VOC emissions increased but remain well below the emission target.
- San Joaquin Valley NAA: VOC emissions increased, placing NAA further out of compliance. However, using adjusted emission inventory calculations significantly reduces the extent of noncompliance.
- Southeast Desert NAA: VOC emissions decreased, but remain slightly out of compliance.
- Ventura NAA: VOC emissions decreased, but remain out of compliance. However, using adjusted emission inventory calculations significantly reduces the extent of noncompliance.
- South Coast NAA: VOC emissions decreased and remain well below the emission target.

VOC emissions for some of the pesticides may be anomalous. Sulfur products are among the top ten contributors for the Sacramento Metropolitan NAA. EPs for most sulfur products are less than one percent, but emissions can be high due to high use. DPR is working with the U.S. Department of Agriculture to confirm the EPs for sulfur products. Propylene oxide is also among the top ten contributors in the Sacramento Metropolitan NAA, and its emissions have increased in the San Joaquin Valley NAA in recent years. Propylene oxide is used exclusively for post-harvest fumigation and may or may not be an agricultural use. In addition, the Air Pollution Control Districts may include some or all of the same propylene oxide emissions in their emission inventories, resulting in double-counting of the emissions. DPR may adjust its propylene oxide emissions after further evaluation and discussion with the Air Pollution Control Districts.

VOC emissions for one petroleum oil product (and a subregistration product) are unusual. The product previously had no EP data, so DPR assigned a default EP of 1.53 percent. Thermogravimetric analysis data submitted as a result of DPR's data call-in (DPR notice 2005-03) documented an EP of 23.95 percent, much higher than other petroleum oil products. This revision caused a substantial change in VOC emissions assigned to this product due to high use. For example, the 2006 emissions for the San Joaquin Valley NAA increased approximately 1.9 tpd (10 percent of the pesticide inventory) by revising the EP from 1.53 to 23.95 percent. DPR will further evaluate this product, but the data appears valid at this time.

Sacramento Metropolitan–Nonattainment Area 1

The emissions in NAA 1 have increased since the lowest rate in 2004. Adjusted emissions in 2004 were 1.323 tpd and have increased to 1.502 tpd in 2006 below emission target of 2.457 tpd (Table 1, Figure 1). In 2005 chlorpyrifos, a widely used insecticide, was the primary contributor and accounted for 13 percent of the emissions (Table 2a). The amount of chlorpyrifos used decreased from 0.186 tpd in 2005 to 0.115 tpd in 2006 (Tables 2a and 2b). The rice herbicide molinate accounted for the second highest amount of emissions in 2005 (0.093 tpd), down from 0.198 tpd in 2004. Molinate use is being phased out, and this is reflected by a further reduction in emissions in 2006 to 0.046 tpd. This is consistent with reported use in NAA 1, which decreased from over

150,000 pounds AI used in 2004 to 52,000 pounds in 2005, and just over 30,000 pounds in 2006. Emissions from metam-sodium, a pre-plant fumigant, increased from 2005 to 2006. Adjusted emission calculations showed an increase from 0.028 tpd in 2005 to 0.063 tpd in 2006 (Tables 2a and 2b). Major commodities/sites include processing tomatoes, structural pest control, walnuts, and rice (Appendix 1).

TABLE 2a. Top ten primary AIs contributing to **2005** May–October ozone season *adjusted* VOC emissions in NAA 1, the Sacramento Metropolitan Area.

Primary AI	Total Product Emissions (tons/day)	Percent of All NAA 1 May–Oct. 2005 Adjusted Emissions
CHLORPYRIFOS	0.186	13.53
MOLINATE	0.093	6.78
THIOBENCARB	0.070	5.11
TRIFLURALIN	0.064	4.63
PERMETHRIN	0.058	4.18
SULFUR	0.054	3.96
PETROLEUM OIL, UNCLASSIFIED	0.050	3.66
ETHALFLURALIN	0.048	3.47
CYPERMETHRIN	0.044	3.17
SETHOXYDIM	0.039	2.82

TABLE 2b. Top ten primary AIs contributing to **2006** May–October ozone season *adjusted* VOC emissions in NAA 1, the Sacramento Metropolitan Area.

Primary AI	Total Product Emissions (tons/day)	Percent of All NAA 1 May–Oct. 2006 Adjusted Emissions
TRIFLURALIN	0.123	8.19
CHLORPYRIFOS	0.115	7.63
ETHALFLURALIN	0.082	5.45
METAM SODIUM	0.063	4.22
PROPYLENE OXIDE	0.056	3.74
1,3 DICHLOROPROPENE	0.055	3.64
SULFUR	0.050	3.32
HYDROPRENE	0.047	3.15
PETROLEUM OIL, UNCLASSIFIED	0.047	3.15
MOLINATE	0.046	3.05

San Joaquin Valley–Nonattainment Area 2

Adjusted emissions in 2004 were 18.490 tpd and increased to 22.895 tpd in 2005 and 24.159 tpd in 2006. Both years' emissions are well above the emission target of 16.070 tpd (Table 1 and Figure 1). Fumigants accounted for 30.2 percent and 28.2 percent of the 2005 and 2006 adjusted emissions, respectively (Tables 3a and 3b). A substantial emission contribution for both years was derived from the nonfumigant, chlorpyrifos. Petroleum oil appears as a top contributor due to the revision of the emission potential of a high-use product, as discussed above. Major commodities/sites include carrots, cotton, almonds, and oranges (Appendix 1).

TABLE 3a. Top ten primary AIs contributing to **2005** May–October ozone season *adjusted* VOC emissions in NAA 2, the San Joaquin Valley.

Primary AI	Total Product Emissions (tons/day)	Percent of All NAA 2 May–Oct. 2005 Adjusted Emissions
CHLORPYRIFOS	3.869	16.90
METAM SODIUM	2.843	12.42
1,3 DICHLOROPROPENE	2.364	10.32
PETROLEUM OIL, UNCLASSIFIED	1.699	7.42
METHYL BROMIDE	1.073	4.69
OXYFLUORFEN	0.749	3.27
DIMETHOATE	0.650	2.84
GIBBERELLINS	0.628	2.74
ACROLEIN	0.572	2.50
ABAMECTIN	0.523	2.28

TABLE 3b. Top ten primary AIs contributing to **2006** May–October ozone season *adjusted* VOC emissions in NAA 2, the San Joaquin Valley.

Primary AI	Total Product Emissions (tons/day)	Percent of All NAA 2 May–Oct. 2006 Adjusted Emissions
CHLORPYRIFOS	3.990	16.52
METAM SODIUM	2.568	10.63
PETROLEUM OIL, UNCLASSIFIED	2.216	9.17
1,3 DICHLOROPROPENE	2.059	8.52
METHYL BROMIDE	1.121	4.64
OXYFLUORFEN	0.779	3.22
METAM POTASSIUM	0.770	3.19
GIBBERELLINS	0.679	2.81
TRIFLURALIN	0.677	2.80
DIMETHOATE	0.645	2.67

Southeast Desert–Nonattainment Area 3

Since 2004, ozone season VOC emissions for NAA 3 have shown a decreasing trend. Total adjusted emissions for the Southeast Desert declined steadily from 2004 to 2006 to a rate of 0.635 tpd (Table 1 and Figure 1). While still out of compliance, this rate is very close to the target adjusted emission rate of 0.627 tpd. In 2005, metam-sodium accounted for approximately 44 percent of the adjusted emissions at 0.323 tpd (Table 4a), and increase slightly to 0.338 tpd in 2006 (Table 4b). The increased percentage to 53.2 percent corresponds to a reduction in the adjusted methyl bromide emissions from 0.048 tpd in 2005 to less than 0.008 tpd in 2006. Major commodities/sites include carrots, strawberries, peppers, and structural pest control (Appendix 1).

TABLE 4a. Top ten primary AIs contributing to **2005** May–October ozone season *adjusted* VOC emissions in NAA 3, the Southeast Desert.

Primary AI	Total Product Emissions (tons/day)	Percent of All NAA 3 May–Oct. 2005 Adjusted Emissions
METAM SODIUM	0.323	43.49
PERMETHRIN	0.079	10.62
METHYL BROMIDE	0.048	6.45
1,3 DICHLOROPROPENE	0.035	4.76
CHLOROPICRIN	0.033	4.44
METAM POTASSIUM	0.031	4.18
MALATHION	0.011	1.46
EPTC	0.011	1.45
BENSULIDE	0.010	1.41
TRICLOPYR, BUTOXYETHYL ESTER	0.009	1.28

TABLE 4b. Top ten primary AIs contributing to **2006** May–October ozone season *adjusted* VOC emissions in NAA 3, the Southeast Desert.

Primary AI	Total Product Emissions (tons/day)	Percent of All NAA 3 May–Oct. 2006 Adjusted Emissions
METAM SODIUM	0.338	53.19
1,3 DICHLOROPROPENE	0.041	6.40
PERMETHRIN	0.032	4.99
BENSULIDE	0.028	4.39
CHLOROPICRIN	0.025	3.97
GLYPHOSATE, ISOPROPYLAMINE SALT	0.009	1.40
MEFENOXAM	0.009	1.38
GIBBERELLINS	0.009	1.34
PENDIMETHALIN	0.008	1.22
MALATHION	0.008	1.21

Ventura–Nonattainment Area 4

Ozone season adjusted emissions decreased from 3.937 tpd in 2004 to 3.639 tpd in 2005, but then increased to 3.738 tpd in 2006 (Table and Figure 1). As in previous years, fumigants dominate the pesticide inventory for this NAA, accounting for 85 percent of the emissions. The adjusted emissions for NAA 4 in 2004 differ significantly from those estimated by Barry, et al. (2007), due to a revision of MUFs. For 2004 in NAA 4, the adjusted emissions changed from 4.826 tpd to 3.937 tpd. The difference is due to information indicating more frequent use of lower emission fumigation methods than previously estimated. Major commodities/sites include strawberries, tomatoes, raspberries, and lemons (Appendix 1).

TABLE 5a. Top ten primary AIs contributing to **2005** May–October ozone season *adjusted* VOC emissions in NAA 4, Ventura.

Primary AI	Total Product Emissions (tons/day)	Percent of All NAA 4 May–Oct. 2005 Adjusted Emissions
METHYL BROMIDE	1.227	33.72
CHLOROPICRIN	1.166	32.06
1,3 DICHLOROPROPENE	0.659	18.10
CHLORPYRIFOS	0.086	2.36
PETROLEUM OIL, UNCLASSIFIED	0.068	1.86
METAM SODIUM	0.060	1.65
OXAMYL	0.029	0.79
CLARIFIED HYDROPHOBIC EXTRACT OF NEEM OIL	0.029	0.79
ABAMECTIN	0.027	0.73
MINERAL OIL	0.026	0.70

TABLE 5b. Top ten primary AIs contributing to **2006** May–October ozone season *adjusted* VOC emissions in NAA 4, Ventura.

Primary AI	Total Product Emissions (tons/day)	Percent of All NAA 4 May–Oct. 2006 Adjusted Emissions
METHYL BROMIDE	1.218	32.58
CHLOROPICRIN	1.164	31.13
1,3 DICHLOROPROPENE	0.723	19.34
PETROLEUM OIL, UNCLASSIFIED	0.083	2.23
METAM SODIUM	0.069	1.86
CHLORPYRIFOS	0.066	1.76
MINERAL OIL	0.042	1.12
OXAMYL	0.036	0.96
AZADIRACHTIN	0.035	0.94
ABAMECTIN	0.027	0.71

South Coast–Nonattainment Area 5

In the South Coast NAA, adjusted emissions have declined steadily since 2000. Adjusted emissions were 1.920 tpd in 2004, and although they increased slightly to 1.983 tpd in 2005, they declined to 1.501 tpd in 2006, well below the target rate of 4.071 tpd. The fumigants methyl bromide, 1,3-dichloropropene, and chloropicrin contributed to 28.8 percent of 2005 adjusted emissions and 27.1 percent of 2006 adjusted emissions (Tables 6a and 6b). Permethrin, an insecticide used on a wide range of commodities, was the largest single contributor to the adjusted inventory accounting for approximately 20 percent of the emissions. Major commodities/sites include structural pest control, strawberries, and landscape maintenance.

TABLE 6a. Top ten primary AIs contributing to **2005** May–October ozone season *adjusted* VOC emissions in NAA 5, South Coast.

Primary AI	Total Product Emissions (tons/day)	Percent of All NAA 5 May–Oct. 2005 Adjusted Emissions
PERMETHRIN	0.458	22.94
METHYL BROMIDE	0.348	17.43
CHLOROPICRIN	0.147	7.39
BIFENTHRIN	0.081	4.05
IMIDACLOPRID	0.081	4.04
1,3 DICHLOROPROPENE	0.079	3.97
N-OCTYL BICYCLOHEPTENE DICARBOXIMIDE	0.066	3.30
LIMONENE	0.056	2.83
PIPERONYL BUTOXIDE	0.053	2.64
CYFLUTHRIN	0.051	2.57

TABLE 6b. Top ten primary AIs contributing to **2006** May–October ozone season *adjusted* VOC emissions in NAA 5, South Coast.

Primary AI	Total Product Emissions (tons/day)	Percent of All NAA 5 May–Oct. 2006 Adjusted Emissions
PERMETHRIN	0.281	18.60
METHYL BROMIDE	0.247	16.33
CHLOROPICRIN	0.119	7.89
IMIDACLOPRID	0.096	6.35
N-OCTYL BICYCLOHEPTENE DICARBOXIMIDE	0.070	4.61
BIFENTHRIN	0.067	4.42
FIPRONIL	0.045	2.96
CYFLUTHRIN	0.044	2.90
1,3 DICHLOROPROPENE	0.043	2.86
CYPERMETHRIN	0.039	2.56

III. PRELIMINARY PROJECTION FOR 2009 VOLATILE ORGANIC COMPOUND EMISSIONS IN THE SAN JOAQUIN VALLEY, SOUTHEAST DESERT, AND VENTURA NONATTAINMENT AREAS

Regulations require DPR to establish a fumigant limit for NAAs that exceed 80 percent of the pesticide VOC benchmark. (NOTE: Benchmark is 20 percent reduction or 80 percent of 1991 emissions. Trigger for fumigant limit is 64 percent [80 percent of 80 percent] of 1991 emissions). Based on the available data, the San Joaquin Valley, Southeast Desert, and Ventura NAAs are likely to exceed their fumigant limit triggers for 2009 (Table 1 and Figure 1). The regulations require DPR to determine the fumigant limit for the upcoming year by subtracting the nonfumigant emissions from the regulatory benchmark. DPR proposes to determine nonfumigant emissions for the upcoming year by using the data from the single most recent year. For example, DPR proposes to use the nonfumigant emissions for 2007 to determine the fumigant limit for 2009. At the time of this memorandum, DPR has released pesticide use data for 2005 and 2006, and is awaiting publication of the 2007 pesticide use report. Therefore, preliminary projected emissions for 2009 are based on 2006 data, and should be regarded merely as a guideline (Table 7). Projections for 2009 will be revised once 2007 data becomes available.

TABLE 7. Preliminary projection for 2009 VOC emissions for NAAs 2, 3, and 4. The 2009 projected fumigant limits are determined by subtracting the 2006 nonfumigant emissions from the regulation benchmarks.

NonAttainment Area	Regulation Benchmark (tons/day)	2006 Nonfumigant Emissions (tons/day)	2009 Projected Fumigant Limit (tons/day)	2006 Adjusted Fumigant Emissions (tons/day)
2–San Joaquin Valley	16.0	17.356	-1.356	6.803
3–Southeast Desert	0.62	0.223	0.397	0.413
4–Ventura	2.6	0.563	2.037	3.175

To reduce VOC emissions by 20 percent, DPR has focused on limiting fumigant emissions, implementing regulations that prohibit higher emitting application methods. Switching to "low-emission" fumigation methods should minimize the impact of the fumigant limit in the Southeast Desert NAA. The Ventura NAA will continue to be impacted by the fumigant limit, although decreases in nonfumigant emissions should lessen the effect. In light of the elevated nonfumigant emissions in the San Joaquin Valley, even the use to low-emission fumigation methods would not enable this NAA to attain compliance. In fact, nonfumigant emissions alone exceed the regulation benchmark by 1.356 tpd for 2006 in the San Joaquin Valley NAA. Therefore, setting a fumigant limit of zero pounds would not achieve the regulation benchmark for this NAA, assuming emissions in 2007 remain the same as 2006 (Figure 2). However, much of the recent increase in VOC emissions is attributable to unusual EP data for a single high-use petroleum oil product. This assessment may change after further evaluation.

IV. CONCLUSIONS

In both 2005 and 2006 NAA 1 (Sacramento Metropolitan) and NAA 5 (South Coast) were the only two regions with emission rates below their respective attainment goals. The South Coast NAA continues a downward trend, whereas Sacramento Metropolitan NAA emissions have increased in both 2005 and 2006. Emission rates for NAA 3 (Southeast Desert) were significantly lower than those in 2004, and the use of adjusted emission calculations resulted in a rate for 2006 that is just above the attainment goal. NAA 2 (San Joaquin Valley) produced successively higher emissions from 2004 to 2006, with most of the increase due to nonfumigants. It will probably be necessary to address the issue of nonfumigant emissions in 2009 if emission goals are to be met in this NAA. Emissions declined for NAA 4 (Ventura) between 2004 and 2006. However, emissions for NAA 4 continue to exceed attainment goals. In general, fumigants were a major source of emissions in all regions except NAA 1 and unless these emissions are significantly reduced, NAA 2, NAA 3, and NAA 4 will continue to fail to meet their attainment goals. In addition, increased use of emulsifiable concentrate formulations in the San Joaquin NAA are contributing significantly to elevated emission rates and reductions will need to be addressed if attainment goals are to be met.

REFERENCES

Barry, T., F. Spurlock and R. Segawa. September 29, 2007, memorandum to J. Sanders: Pesticide Volatile Organic Compound Emission Adjustments For Field Conditions And Estimated Volatile Organic Compound Reductions–Revised Estimates. Available at: <http://www.cdpr.ca.gov/docs/emon/pubs/ehapreps/analysis_memos/1955_sanders.pdf>.

Eastern District of California. 2006. No. Civ. S-04-882 (E.D. Cal. filed April 6, 2006), *enforcing El Comité Para el Bienestar de Earlimart v. Helliker*, 416 F. Supp. 2d 912. Federal Register, January 8, 1997. Volume 62, No. 5, p. 1170.

Spurlock, F., 2006. July 18, 2006, memorandum to J. Sanders: 2006 Revisions to Procedures for Estimating Volatile Organic Compound Emissions from Pesticides.

Spurlock, F. January 7, 2002 memorandum to J. Sanders. Methodology for determining VOC emission potential of pesticide products. Available at: <http://www.cdpr.ca.gov/docs/emon/vocs/vocproj/intro.pdf>.

FIGURE 1. Annual ozone season pesticide VOC emissions by NAA. These figures show both adjusted emissions, and use 1991 as the base year for a 20 percent reduction.

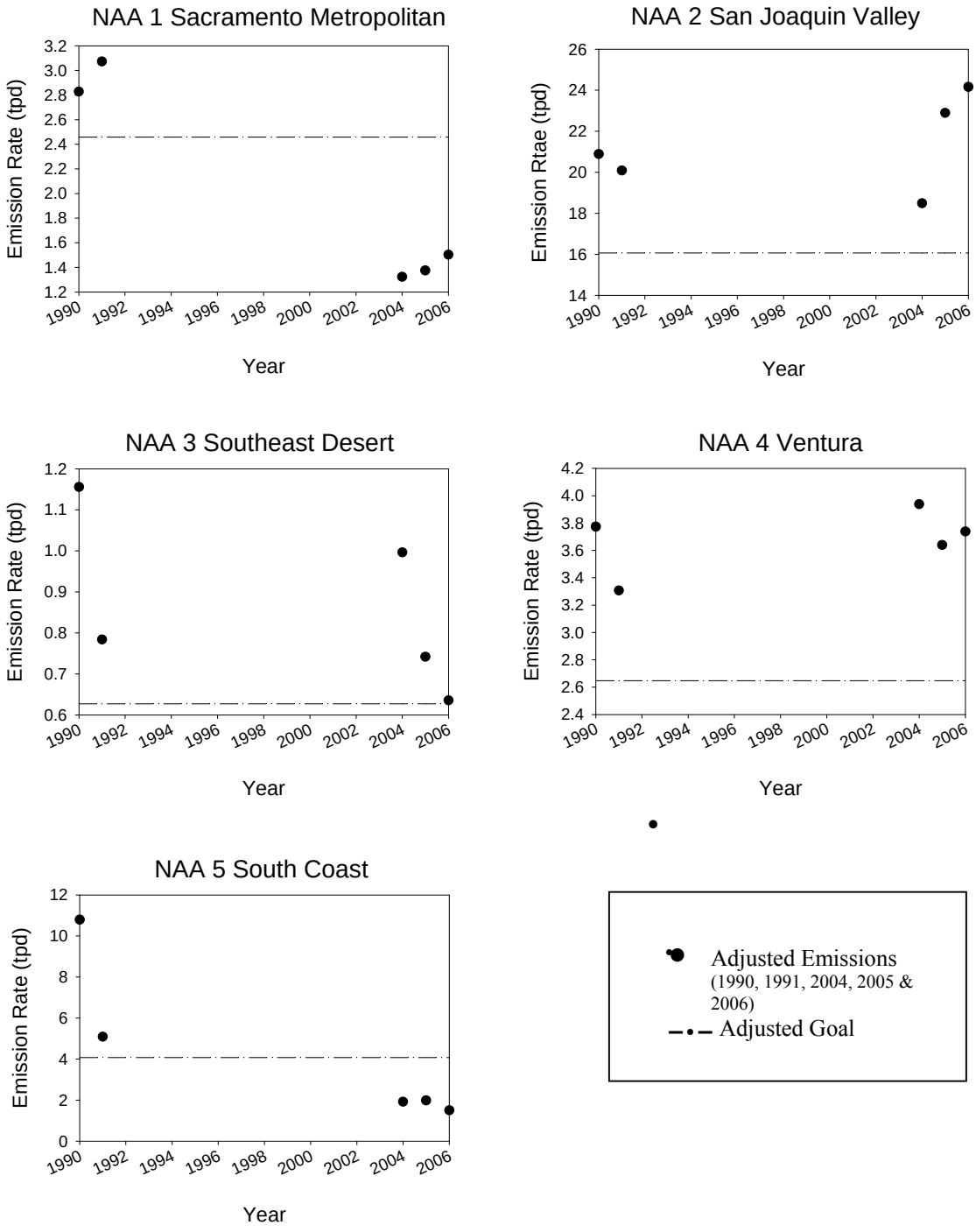
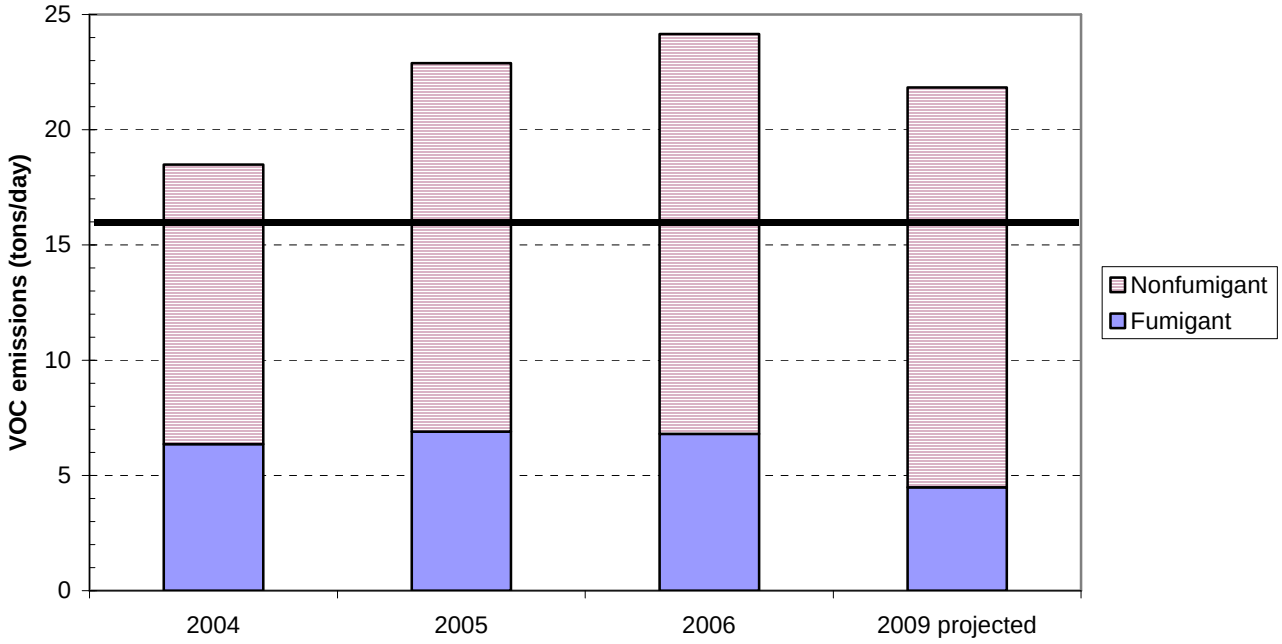


FIGURE 2. Pesticide VOC emissions for the San Joaquin Valley NAA, May–October. Emissions for each year are divided into fumigants and nonfumigants. Fumigant emissions are adjusted to account for fumigation method. Emissions for 2009 are projected using the 2006 emissions and expected fumigant reductions due to VOC regulations. Emissions for 2004 are shown for comparison. Estimates for 2009 will be revised once 2007 data becomes available. The solid line indicates the emissions benchmark specified in VOC regulations (20 percent reduction from 1991).



APPENDIX 1. SUMMARY OF UNADJUSTED PESTICIDE VOLATILE ORGANIC COMPOUND EMISSIONS

Sacramento Metropolitan–Nonattainment Area 1

TABLE 8a. Top ten primary AIs contributing to **2005** May–October ozone season *unadjusted* VOC emissions in NAA 1, the Sacramento Metropolitan Area.

Primary AI	Total Product Emissions (tons/day)	Percent of all NAA 1 May–Oct. 2005 emissions
CHLORPYRIFOS	0.186	12.90
MOLINATE	0.093	6.47
THIOBENCARB	0.070	4.88
TRIFLURALIN	0.064	4.42
1,3-DICHLOROPROPENE	0.062	4.31
PERMETHRIN	0.058	3.99
SULFUR	0.054	3.77
METAM-SODIUM	0.051	3.56
PETROLEUM OIL, UNCLASSIFIED	0.050	3.49
ETHALFLURALIN	0.048	3.31

TABLE 8b. Top ten primary AIs contributing to **2006** May–October ozone season *unadjusted* VOC emissions in NAA 1, the Sacramento Metropolitan Area.

Primary AI	Total Product Emissions (tons/day)	Percent of all NAA 1 May–Oct. 2006 emissions
1,3-DICHLOROPROPENE	0.143	8.64
TRIFLURALIN	0.123	7.44
METAM-SODIUM	0.116	6.98
CHLORPYRIFOS	0.115	6.92
ETHALFLURALIN	0.082	4.95
PROPYLENE OXIDE	0.056	3.39
SULFUR	0.050	3.02
HYDROPRENE	0.047	2.86
PETROLEUM OIL, UNCLASSIFIED	0.047	2.86
MOLINATE	0.046	2.77

TABLE 9a. Top ten pesticide application sites contributing to **2005** May–October ozone season *unadjusted* VOC emissions in NAA 1.

Application Site	Emissions (tons/day)	Percent of all NAA 1 May–Oct. 2005 emissions
RICE	0.229	15.91
STRUCTURAL PEST CONTROL	0.219	15.20
WALNUT	0.164	11.38
GRAPE, WINE	0.148	10.24
TOMATO, PROCESSING	0.137	9.50
COMMODITY FUMIGATION	0.068	4.74
RIGHTS OF WAY	0.063	4.39
ALFALFA	0.059	4.10
SOIL FUMIGATION/PREPLANT	0.054	3.76
LANDSCAPE MAINTENANCE	0.044	3.07

TABLE 9b. Top ten pesticide application sites contributing to **2006** May–October ozone season *unadjusted* VOC emissions in NAA 1.

Application Site	Emissions (tons/day)	Percent of all NAA 1 May–Oct. 2006 emissions
TOMATO, PROCESSING	0.251	15.19
STRUCTURAL PEST CONTROL	0.218	13.16
WALNUT	0.177	10.70
RICE	0.176	10.66
GRAPE, WINE	0.118	7.11
COMMODITY FUMIGATION	0.094	5.71
SOIL FUMIGATION/PREPLANT	0.094	5.70
SUNFLOWER	0.083	5.04
RIGHTS OF WAY	0.073	4.42
ALFALFA	0.044	2.69

TABLE 10a. *Unadjusted* **2005** May–October VOC emissions in NAA1 by ARB emission inventory classification (tpd).

NAA 1–2005	**Agricultural Applications**	**Structural Applications**
METHYL BROMIDE EMISSIONS	0.035	0.000
NONMETHYL BROMIDE EMISSIONS	1.185	0.219

TABLE 10b. *Unadjusted* **2006** May–October VOC emissions in NAA1 by ARB emission inventory classification (tpd).

NAA 1–2006	**Agricultural Applications**	**Structural Applications**
METHYL BROMIDE EMISSIONS	0.037	0.000
NONMETHYL BROMIDE EMISSIONS	1.398	0.218

San Joaquin Valley–Nonattainment Area 2

TABLE 11a. Top ten primary AIs contributing to **2005** May–October ozone season *unadjusted* VOC emissions in NAA 2, the San Joaquin Valley.

Primary AI	Total Product Emissions (tons/day)	Percent of all NAA 2 May–Oct. 2005 emissions
1,3-DICHLOROPROPENE	5.938	19.00
METAM-SODIUM	5.912	18.91
CHLORPYRIFOS	3.869	12.38
METHYL BROMIDE	2.461	7.87
PETROLEUM OIL, UNCLASSIFIED	1.699	5.44
POTASSIUM N-METHYLDITHIOCARBAMATE	0.928	2.97
OXYFLUORFEN	0.749	2.40
DIMETHOATE	0.650	2.08
GIBBERELLINS	0.628	2.01
ACROLEIN	0.572	1.83

TABLE 11b. Top ten primary AIs contributing to **2006** May–October ozone season *unadjusted* VOC emissions in NAA 2, the San Joaquin Valley.

Primary AI	Total Product Emissions (tons/day)	Percent of all NAA 2 May–Oct. 2006 emissions
METAM-SODIUM	5.340	16.53
1,3-DICHLOROPROPENE	5.094	15.77
CHLORPYRIFOS	3.990	12.35
METHYL BROMIDE	2.645	8.19
PETROLEUM OIL, UNCLASSIFIED	2.216	6.86
POTASSIUM N-METHYLDITHIOCARBAMATE	1.601	4.96
OXYFLUORFEN	0.779	2.41
GIBBERELLINS	0.679	2.10
TRIFLURALIN	0.677	2.10
DIMETHOATE	0.645	2.00

TABLE 12a. Top ten pesticide application sites contributing to **2005** May–October ozone season *unadjusted* VOC emissions in NAA 2.

Application Site	Emissions (tons/day)	Percent of all NAA 2 May–Oct. 2005 emissions
CARROT	5.096	16.30
ALMOND	3.289	10.52
COTTON	3.033	9.70
ORANGE	2.631	8.42
N-OUTDR PLANTS IN CONTAINERS	1.858	5.94
GRAPE	1.241	3.97
GRAPE, WINE	1.238	3.96
WALNUT	1.204	3.85
ALFALFA	1.015	3.25
POTATO	0.878	2.81

TABLE 12b. Top ten pesticide application sites contributing to **2006** May–October ozone season *unadjusted* VOC emissions in NAA 2.

Application Site	Emissions (tons/day)	Percent of all NAA 2 May–Oct. 2006 emissions
ALMOND	4.898	15.16
CARROT	4.308	13.34
COTTON	2.625	8.13
ORANGE	2.487	7.70
N-OUTDR PLANTS IN CONTAINERS	1.605	4.97
WALNUT	1.196	3.70
SOIL FUMIGATION/PREPLANT	1.152	3.57
POTATO	1.105	3.42
GRAPE	1.050	3.25
ALFALFA	1.029	3.19

TABLE 13a. *Unadjusted* **2005** May–October VOC emissions in NAA 2 by ARB emission inventory classification (tpd).

NAA 2–2005	**Agricultural Applications**	**Structural Applications**
METHYL BROMIDE EMISSIONS	2.126	0.008
NONMETHYL BROMIDE EMISSIONS	28.390	0.409

TABLE 13b. *Unadjusted* **2006** May–October VOC emissions in NAA 2 by ARB emission inventory classification (tpd).

NAA 2–2006	**Agricultural Applications**	**Structural Applications**
METHYL BROMIDE EMISSIONS	2.200	0.029
NONMETHYL BROMIDE EMISSIONS	29.365	0.293

Southeast Desert–Nonattainment Area 3

TABLE 14a. Top ten primary AIs contributing to **2005** May–October ozone season *unadjusted* VOC emissions in NAA 3, the Southeast Desert.

Primary AI	Total Product Emissions (tons/day)	Percent of all NAA 3 May–Oct. 2005 emissions
METAM-SODIUM	0.503	44.49
1,3-DICHLOROPROPENE	0.181	15.97
METHYL BROMIDE	0.106	9.39
PERMETHRIN	0.079	6.97
POTASSIUM N-METHYLDITHIOCARBAMATE	0.048	4.28
DAZOMET	0.025	2.17
MALATHION	0.011	0.96
EPTC	0.011	0.95
BENSULIDE	0.010	0.92
TRICLOPYR, BUTOXYETHYL ESTER	0.009	0.84

TABLE 14b. Top ten primary AIs contributing to **2006** May–October ozone season *unadjusted* VOC emissions in NAA 3, the Southeast Desert.

Primary AI	Total Product Emissions (tons/day)	Percent of all NAA 3 May–Oct. 2006 emissions
METAM-SODIUM	0.527	54.31
1,3-DICHLOROPROPENE	0.201	20.74
PERMETHRIN	0.032	3.26
BENSULIDE	0.028	2.87
METHYL BROMIDE	0.015	1.52
GLYPHOSATE, ISOPROPYLAMINE SALT	0.009	0.91
MEFENOXAM	0.009	0.90
GIBBERELLINS	0.009	0.88
PENDIMETHALIN	0.008	0.80
MALATHION	0.008	0.79

TABLE 15a. Top ten pesticide application sites contributing to **2005** May–October ozone season *unadjusted* VOC emissions in NAA 3.

Application Site	Emissions (tons/day)	Percent of all NAA 3 May–Oct. 2005 emissions
CARROT	0.196	17.31
STRAWBERRY	0.161	14.25
STRUCTURAL PEST CONTROL	0.129	11.38
PEPPER, FRUITING	0.125	11.06
UNCULTIVATED AG*	0.086	7.65
GRAPE	0.082	7.23
LANDSCAPE MAINTENANCE	0.054	4.76
CELERY	0.048	4.28
POTATO	0.046	4.04
CAULIFLOWER	0.041	3.65

***** Treatment of an area prior to determining which crop will be planted

TABLE 15b. Top ten pesticide application sites contributing to **2006** May–October ozone season *unadjusted* VOC emissions in NAA 3.

Application Site	Emissions (tons/day)	Percent of all NAA 3 May–Oct. 2006 emissions
UNCULTIVATED AG*	0.20	21.09
PEPPER, FRUITING	0.19	19.38
STRAWBERRY	0.16	16.81
STRUCTURAL PEST CONTROL	0.07	7.42
CARROT	0.05	4.81
WATERMELON	0.04	4.42
POTATO	0.04	4.05
LANDSCAPE MAINTENANCE	0.04	4.05
CELERY	0.03	3.22
LETTUCE, LEAF	0.02	2.49

***** Treatment of an area prior to determining which crop will be planted

TABLE 16a. *Unadjusted* **2005** May–October VOC emissions in NAA 3 by ARB emission inventory classification (tpd).

NAA 3–2005	**Agricultural Applications**	**Structural Applications**
METHYL BROMIDE EMISSIONS	0.081	0.000
NONMETHYL BROMIDE EMISSIONS	0.895	0.130

TABLE 16b. *Unadjusted* **2006** May–October VOC emissions in NAA 3 by ARB emission inventory classification (tpd).

NAA 3–2006	**Agricultural Applications**	**Structural Applications**
METHYL BROMIDE EMISSIONS	0.013	0.000
NONMETHYL BROMIDE EMISSIONS	0.883	0.074

Ventura–Nonattainment Area 4

TABLE 17a. Top ten primary AIs contributing to **2005** May–October ozone season *unadjusted* VOC emissions in NAA 4, Ventura.

Primary AI	Total Product Emissions (tons/day)	Percent of all NAA 4 May–Oct. 2005 emissions
1,3-DICHLOROPROPENE	3.633	38.83
METHYL BROMIDE	3.601	38.49
CHLOROPICRIN	1.142	12.21
METAM-SODIUM	0.418	4.47
CHLORPYRIFOS	0.086	0.92
PETROLEUM OIL, UNCLASSIFIED	0.068	0.72
POTASSIUM N-METHYLDITHIOCARBAMATE	0.034	0.36
OXAMYL	0.029	0.31
CLARIFIED HYDROPHOBIC EXTRACT OF NEEM OIL	0.029	0.31
ABAMECTIN	0.027	0.28

TABLE 17b. Top ten primary AIs contributing to **2006** May–October ozone season *unadjusted* VOC emissions in NAA 4, Ventura.

Primary AI	Total Product Emissions (tons/day)	Percent of all NAA 4 May–Oct. 2006 emissions
1,3-DICHLOROPROPENE	3.970	41.03
METHYL BROMIDE	3.646	37.69
CHLOROPICRIN	1.009	10.43
METAM-SODIUM	0.482	4.98
PETROLEUM OIL, UNCLASSIFIED	0.083	0.86
CHLORPYRIFOS	0.066	0.68
MINERAL OIL	0.042	0.43
OXAMYL	0.036	0.37
AZADIRACHTIN	0.035	0.36
ABAMECTIN	0.027	0.27

TABLE 18a. Top ten pesticide application sites contributing to **2005** May–October ozone season *unadjusted* VOC emissions in NAA 4.

Application Site	Emissions (tons/day)	Percent of all NAA 4 May–Oct. 2005 emissions
STRAWBERRY	6.648	71.06
SOIL FUMIGATION/PREPLANT	1.579	16.88
LEMON	0.209	2.24
RASPBERRY	0.198	2.11
TOMATO	0.180	1.93
UNCULTIVATED AG	0.131	1.40
PEPPER, FRUITING	0.094	1.01
N-OUTDR FLOWER	0.062	0.66
CELERY	0.035	0.37
STRUCTURAL PEST CONTROL	0.035	0.37

TABLE 18b. Top ten pesticide application sites contributing to **2006** May–October ozone season *unadjusted* VOC emissions in NAA 4.

Application Site	Emissions (tons/day)	Percent of all NAA 4 May–Oct. 2006 emissions
STRAWBERRY	6.365	65.79
SOIL FUMIGATION/PREPLANT	2.200	22.74
TOMATO	0.237	2.45
LEMON	0.215	2.23
RASPBERRY	0.099	1.03
CELERY	0.099	1.03
PEPPER, FRUITING	0.086	0.89
N-OUTDR FLOWER	0.059	0.61
PEPPER, SPICE	0.054	0.56
AVOCADO	0.043	0.45

TABLE 19a. *Unadjusted* **2005** May–October VOC emissions in NAA 4 by ARB emission inventory classification (tpd).

NAA 4–2005	**Agricultural Applications**	**Structural Applications**
METHYL BROMIDE EMISSIONS	2.556	0.000
NONMETHYL BROMIDE EMISSIONS	5.417	0.035

TABLE 19b. *Unadjusted* **2006** May–October VOC emissions in NAA 4 by ARB emission inventory classification (tpd).

NAA 4–2006	**Agricultural Applications**	**Structural Applications**
METHYL BROMIDE EMISSIONS	2.537	0.000
NONMETHYL BROMIDE EMISSIONS	5.782	0.024

South Coast–Nonattainment Area 5

TABLE 20a. Top ten primary aAIs contributing to **2005** May–October ozone season *unadjusted* VOC emissions in NAA 5, South Coast.

Primary AI	Total Product Emissions (tons/day)	Percent of all NAA 5 May–Oct. 2005 emissions
METHYL BROMIDE	0.688	25.57
PERMETHRIN	0.458	17.01
1,3-DICHLOROPROPENE	0.446	16.57
CHLOROPICRIN	0.082	3.06
BIFENTHRIN	0.081	3.00
IMIDACLOPRID	0.081	2.99
N-OCTYL BICYCLOHEPTENE DICARBOXIMIDE	0.066	2.45
LIMONENE	0.056	2.10
DAZOMET	0.056	2.09
PIPERONYL BUTOXIDE	0.053	1.96

TABLE 20b. Top ten primary AIs contributing to **2006** May–October ozone season *unadjusted* VOC emissions in NAA 5, South Coast.

Primary AI	Total Product Emissions (tons/day)	Percent of all NAA 5 May–Oct. 2006 emissions
METHYL BROMIDE	0.487	24.65
PERMETHRIN	0.281	14.23
1,3-DICHLOROPROPENE	0.245	12.39
CHLOROPICRIN	0.127	6.45
IMIDACLOPRID	0.096	4.86
N-OCTYL BICYCLOHEPTENE DICARBOXIMIDE	0.070	3.53
BIFENTHRIN	0.067	3.38
FIPRONIL	0.045	2.27
CYFLUTHRIN	0.044	2.22
CYPERMETHRIN	0.039	1.96

TABLE 21a. Top ten pesticide application sites contributing to **2005** May-October ozone season *unadjusted* VOC emissions in NAA 5.

Application Site	Emissions (tons/day)	Percent of all NAA 5 May–Oct. 2005 emissions
STRUCTURAL PEST CONTROL	1.040	38.63
STRAWBERRY	0.856	31.81
LANDSCAPE MAINTENANCE	0.214	7.96
TURF/SOD	0.213	7.90
FUMIGATION, OTHER	0.068	2.51
RIGHTS OF WAY	0.050	1.85
N-OUTDR PLANTS IN CONTAINERS	0.048	1.77
SOIL FUMIGATION/PREPLANT	0.038	1.42
PEPPER, FRUITING	0.036	1.34
COMMODITY FUMIGATION	0.026	0.95

TABLE 21b. Top ten pesticide application sites contributing to **2006** May–October ozone season *unadjusted* VOC emissions in NAA 5.

Application Site	Emissions (tons/day)	Percent of all NAA 5 May–Oct. 2006 emissions
STRUCTURAL PEST CONTROL	0.779	39.43
STRAWBERRY	0.747	37.79
LANDSCAPE MAINTENANCE	0.163	8.26
FUMIGATION, OTHER	0.087	4.40
RIGHTS OF WAY	0.036	1.82
N-OUTDR PLANTS IN CONTAINERS	0.033	1.68
SOIL FUMIGATION/PREPLANT	0.029	1.47
COMMODITY FUMIGATION	0.019	0.98
AVOCADO	0.018	0.91
PEPPER, FRUITING	0.013	0.63

TABLE 22a. *Unadjusted* **2005** May–October VOC emissions in NAA 5 by ARB emission inventory classification (tpd).

NAA 5–2005	**Agricultural Applications**	**Structural Applications**
METHYL BROMIDE EMISSIONS	0.508	0.003
NONMETHYL BROMIDE EMISSIONS	0.964	1.039

TABLE 22b. *Unadjusted* **2006** May–October VOC emissions in NAA 5 by ARB emission inventory classification (tpd).

NAA 5–2006	**Agricultural Applications**	**Structural Applications**
METHYL BROMIDE EMISSIONS	0.360	0.003
NONMETHYL BROMIDE EMISSIONS	0.709	0.780